**Lab 3 | Color**

## Introduction

In this lab you will practice adjusting hue, lightness, and saturation values using three different color models: HSV, CMYK, and RGB. You will also explore color decisions for mapping and create custom color ramps. Some of the material was adapted from Cynthia Brewer’s Cartographic Design for ArcGIS course.

Copy the Lab3data folder to your flash drive.

**Deliverables**

Your lab document should be typed, well organized and submitted according to the “How To” guidelines on the course website (one pdf document with all of your exported maps).

**Part I. Identify Color Characteristics**

**a. Organize colors based on lightness (value)**

***Lightness or value*** *measures the relative degree of black or white that is mixed with a color (hue). Adding white makes the color lighter and adding black makes it darker. The greater the difference in value between colors, the greater the contrast. This makes it a good way to show an order with quantitative data, where light colors imply less of something and dark colors, more.*

* Open ***exer1a.mxd*.** This map document presents a grid of 100 cells. Seven of these cells are elements of a color ramp that varies in lightness.
* Click and drag the orange cells to the bottom row of open (white) cells. Arrange them so that lightness ranges from light to dark (left to right). Save your changes.
1. **Export your map as a jpg (200 dpi). *Start a lab document (in word) and insert the map jpeg*.**

**b.** **Organize colors based on saturation**

***Saturation*** *refers to how pure or intense a hue (color) is. 100% saturation means the color is completely pure (no addition of gray). 0% saturation appears as a medium gray. The more saturated the color (closer to 100%), the more vivid or brighter it appears.*

* Open ***exer1b.mxd***. Drag the colored cells to the bottom row of the grid, arranging them in order of increasing saturation (left to right). Save your changes.
1. ***Export the map and paste it in your lab document***.

**Part II. Navigate Color Space**

* **Open** **exer2.mxd**. This map document has five layers organized in the Specification – HSV data frame. Each layer in the data frame contains a different task. You will mix colors to complete the color schemes. The easiest way to access a symbol's color is to click the symbol next to a data value in the table of contents.

**a. Mix colors to create lightness steps for one hue**

* In the table of contents, expand the L1H layer. Colors 11 and 15 are already specified. Your task is to create a color scheme that varies in lightness between the two endpoints. Think of this as a graduated color scheme you would use to represent quantitative data.

* Click the symbol for data value 12. In the Symbol Selector, click the Fill Color dropdown arrow, and choose More Colors. In the Color Selector, click the dropdown arrow to choose a color space. Choose HSV.
* You can create colors several different ways in the Color Selector. You can move the sliders for each dimension, you can enter numeric values in the percentage boxes, or you can click on the spectrum at the bottom. As you move the sliders, the color bar above each one updates to reflect the change.
* Several advanced settings are also available in the Color Selector. Although you will not use them in this exercise, it is useful to look at the controls. Click Cancel to close the Color Selector. Scroll down the list of preset symbols in the Symbol Selector and click Orange. Reopen the Color Selector. Click the right-facing arrow and choose Advanced Selection. Examine the controls available in the Select Color window. Click Cancel to close the Select Color window.
* Using the HSV sliders in the Color Selector, mix a color for data value 12. As you change the HSV settings, the color box in the bottom left corner will reflect the current color. Click OK when you're finished.
* In the Symbol Selector, the Fill color has updated to match the HSV values you chose. Change the Outline color to Gray 50%. Click OK. The color for data value 12 updates in the table of contents and in the map area.
* Repeat the color mixing process for data values 13 and 14. Create colors that vary in lightness between the endpoints.

**b. Create lightness steps through multiple hues in HSV**

* Expand the L2H layer. The colors in this layer vary in lightness between yellow and dark red. Mix HSV colors for data values 32 through 34.

**c. Create saturation steps for one hue in HSV**

* Expand the S1H layer. This color ramp goes from a light bluish gray to a saturated cyan. Mix HSV colors for data values 52 through 54. The colors should have the same hue setting and vary only in saturation.

**d. Create six hues in HSV**

* Expand the 6H layer. For this color scheme, you are given three colors: red, green, and purple. The task here is to create three more hues that maintain the same lightness and saturation as those given. Mix HSV colors for data values 72, 74, and 75.

**e. Create a dark-light-dark sequence in HSV**

* Expand the DLD layer. This layer has a two-hue color scheme that diverges from a light color in the middle (white) to two dark hues on the ends (bluish-purple on the left and dark orange on the right). Mix colors for data values 92, 93, 95, and 96.
1. ***Export the map and paste it in your lab document***.

**Part III. Practice mixing CMYK and RGB colors**

* ***Open******exer3.mxd****.* This map document contains two data frames: the top data frame contains layers whose colors will be specified using CMYK values, while the bottom data frame contains layers whose colors will be specified using RGB values. The top data frame is currently active. You see its layers in the map display area.
* For the first part of the exercise, you have five tasks, corresponding to the five layers in the Specification - CMYK data frame. For each task, you will use the CMYK sliders in the Color Selector to specify custom colors.

**a. Mix colors using CMYK: lightness steps for one hue**

* In the table of contents, expand the L1H layer to reveal the data symbols.
* Click the symbol for data value 11. In the Symbol Selector, click the Fill Color dropdown arrow and choose More Colors. In the Color Selector, click the dropdown arrow and choose CMYK.
* Note the values for this color. Remember that the currently mixed color is shown both in a box in the lower left corner and in a dynamic color bar above each slider. If you look closely, you will notice that the color ramp above each slider indicates how the color will change when the slider is moved. Click Cancel to close the Color Selector and Symbol Selector.
* Now use the Color Selector to mix CMYK colors for data values 12, 13, and 14. The L1H color ramp should vary in lightness between the endpoints.

**b. Create lightness steps through multiple hues in CMYK**

* Expand the L2H layer. The colors in this layer vary in lightness from yellow to dark blue. Mix CMYK colors for data values 32 through 34. You may want to review the CMYK settings for 31 and 35 first.

**c. Create saturation steps for one hue in CMYK**

* Expand the S1H layer. Mix CMYK colors for data values 52 through 54. These colors should have the same lightness and hue and vary only in saturation.

**d. Create six-hue and dark-light-dark sequences in CMYK**

* Two layers remain: 6H and DLD. Create CMYK colors for these two layers.
* 6H is a qualitative scheme. Choose colors that have similar lightness and saturation to those given and that vary in hue only.
* DLD is a diverging scheme. Choose colors that vary in lightness from the center (white) out to the endpoints.
1. ***Export the map and paste it in your lab document***.

**e. Mix colors using the RGB color space**

* In the table of contents, right-click the Specification - RGB data frame and choose Activate to display its layers in the map area.
* Your task for the remainder of the exercise is the same as in the steps above, but this time you'll use RGB primary colors to fill in the missing colors for the five layers.
* Expand the L1H layer and click the symbol for data value 11. Open the Color Selector and change it to RGB. Examine the RGB values. Cancel out of the Color Selector and Symbol Selector.
* Next, click the symbol for data value 12 and open the Color Selector. Adjust the RGB settings so that data value 12 fits into the light to dark purple color scheme. Mix the colors for 13 and 14.
* Expand the other layers and mix colors for the missing symbols.
1. ***Export the map and paste it in your lab document***.

**Part IV. Match color characteristics to map data**

**a. Examine color schemes**

* ***Open exer4a.mxd***. This map depicts the percentage of people under age 18 identified as two or more races in the 2000 Census. The data are aggregated to the county level. The map has nine color scheme layers. The data are classified identically on each layer.
* Turn off the display of layer 1 and turn on the display of layer 2. Examine the color scheme used to represent the data in this layer. One at a time, examine the color schemes used in the other layers.
1. ***Which color scheme do you think best represents the data mapped? Why?***
2. ***What are the two next best choices? Explain why they do not quite work.***

Compare all the layers. Think about the type of data being mapped. There is only one best choice.

Answer

Layer 6 uses the best color scheme for these data.

Rates suggest a sequential color scheme, such as those used by Layers 3, 6, and 9. Layer 3, however, is a bad choice because there is a big lightness jump between the two darkest colors and the three lightest colors. Layer 9 is a bad choice because the second color has a big difference in saturation from the others.

**b. Examine another map**

* ***Open exer4b.mxd***.This map presents the percent change in population from 1990 to 2000. The data are again aggregated to counties. The U.S. rate of change is 13.2 percent.
* Examine the color scheme used in Layer 1. Next, turn on Layer 2, then turn off Layer1. Investigate each of the other layers, one at a time.
1. ***Which color scheme best represents these data? Why?***
2. ***What are the two next best choices? Explain why they do not quite work.***

Again, consider the type of data being mapped and choose thoughtfully.

Answer

Layer 6 is the best color scheme for these data.

The most important consideration with these data is the national change (13.2 percent). Colors representing gains and losses should diverge from this value. Layer 3 is a bad choice because the hue change does not match the U.S. rate. Layer 9 is a bad choice because the hue choices do not make sense (even though they form diverging lightness ramps).

**c. Examine more color schemes**

* ***Open exer4c.mxd***. The theme of this map is religious affiliation. The map relates, by county, the group with the high percentage of the population. All religious denominations were represented on the complete U.S. map by Gaustad and Barlow, from which this map of the northeast is derived.
* Display and examine each layer.
1. ***Which color scheme is best for these data? Why?***
2. ***What are the two next best choices? Explain why they do not quite work.***

**Part V. Create Custom Color Ramps**

**a. Design your own elevation color ramp**

*You have already seen how you can change individual color swatches, but you can also create* ***custom color ramps****. The easiest way to do this is to modify an existing color ramp, but you can also start from scratch with a new color ramp in Style manager. In this exercise, you will create your own elevation color ramp.*

* Add the DEM and hillshade of Clackmas County to a new blank map. If it asks to build pyramids, say Yes.

* Place the DEM on top of the hillshade and in the Symbology tab for the DEM, choose one of the two elevation color ramps available in ArcMap. If you do not know which two color ramps are intended for elevation, right click on the current color ramp and click off graphic view – this will display the color ramps by name. Scroll down to find Elevation #1 or Elevation #2.
* Adjust the transparency of the DEM in the Display tab of the properties menu for the DEM layer until you can see both the hillshade underneath and the hypsometric tints of the DEM in a combination that you like. You can adjust the appearance of your hillshade in the Symbology tab by adjusting the type of stretching used (e.g., min-max, standard deviations). Try a few different settings to see which appearance you like best.
* Open the properties for the DEM. Right click on the elevation color ramp in the Symbology tab and choose Properties.
* When you are working with a multipart color ramp (like elevation), in the first window you will see the option to add or remove ramps as well as to modify existing ones. Select one of the individual color ramps that comprise the elevation color ramp and click properties again.
* You now have the option to change the beginning and ending colors of the color ramps as well as the amount of white and black. Notice that you have the option of working in three different perceptual color spaces: HSV, CIE Lab, and Lab LCh. These options define how the ramp moves through color space between the two colors you have chosen. Pick HSV.
* Now create a color ramp to get something you like better than the two default elevation color ramps in ArcMap. You can delete individual ramps if you choose or add new ones.
* Your color ramp should be suggestive of the terrain you are mapping. Be sure the ending color for one ramp is the starting color for the next one. Click OK to exit the Edit Color Ramp dialog when you are done.

**\*\*IMPORTANT NOTE: DON’T WASTE YOUR TIME AND EFFORT\*\***

**Before you close out of the Symbology tab, right click on your new color ramp and select Save to Style. If you do not do this, you will display the color ramp, but you will not be able to return to it and modify it.**

* Usually it will take a few tries to get the colors to look good. Just remember to save any color ramp that you create. Feel free to zoom in to a smaller extent if that helps you.
1. ***When you are satisfied with your new color ramp, create a map in layout view of Clackamas county elevation, showing the DEM symbolized with the new color ramp over the hillshade. Include all necessary map elements and create a map that adheres to good map design principles. Export your map and paste it into your lab document***.
* ***Custom styles*** are stored locally on your computer in the folder C:\User\AppData\Roaming\ESRI\Desktop 10.x\ArcMap\<style>. Any styles you create will be named yourname.style. If you want to use these styles on another computer, you must copy the style. You can manage your custom styles using the Style Manager found under Customize\Styles. You can also export styles from the same menu location.

**b. Create a color ramp linked to specific data values**

*You can also create* ***color ramps*** *that are linked to specific data values. To do this you must classify your dataset. This technique is especially useful if you wish to use different color ramps above and below certain data values such as a mean or zero.*

* Open a new blank map and add the Oregon precipitation dataset (or\_precip).
* In the Symbology tab for precipitation, choose classified and then use 10 classes and natural breaks (you can change the classification method if you want, but keep 10 classes). First select the default precipitation color ramp to see what range of hues and tones are used (click off Graphic View to see the names of the color ramps).
* Select a different color ramp. Now pick colors for several specific classes that reflect the color ramps you want to create. Be sure to choose colors that suggest precipitation.
* Try changing the first, fourth, seventh, and tenth classes. Holding down the control key, select the four colors you have just specified, then right click and select Ramp Colors. Algorithmic color ramps will be created between your selected colors.
* You are unlikely to get what you want on the first try, so repeat this process until you get a map display that you like. Save the new ramp as a style.
1. ***When you are satisfied with your new color ramp, create a map in layout view of Oregon precipitation. Include all necessary map elements and create a map that adheres to good map design principles (don’t forget to choose an appropriate projection for the map). Export your map and paste it into your lab document***.